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CASE REPORT

A technique of speech aid adjustment with the assistance of nasalance values for non-nasal and nasal sounds

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ABSTRACT

Evaluation of speech function is essential to maxillofacial prosthetic treatment. Measurement of nasalance with a nasometer is practical and typically done to detect hypernasality in maxillofacial defect patients. This case report describes a nasalance test used in the evaluation and rehabilitation of a patient who needed a speech aid. A 70-year-old man sought help at our clinic because his old speech aid had broken. Although a new speech aid was fabricated, he continued to have difficulty speaking and breathing. A nasalance test using nasal and non-nasal test words revealed hyponasality. The patient was satisfied with the speech aid after its adjustment in accordance with the nasalance test results. Nasalance testing that considers not only hypernasality but hyponasality helped the maxillofacial prosthodontist in the successful rehabilitation of this maxillofacial defect patient. (*Int J Maxillofac Prosthetics 2020;3:23-27*)

INTRODUCTION

Partial coupling of the nasal and oral cavities during articulation of nasal sounds leads to these sounds being perceived as nasalized in normal speech.[1] A problem in the head and neck area, such as a maxillofacial defect or velopharyngeal deficiency, can produce the nasalized articulation of non-nasal sounds, which is called hypernasality. Maxillofacial prosthodontists are responsible for restoring sufficient oral-nasal partition in patients with maxillofacial defects who use prostheses. Placement of an obturator prosthesis or a speech aid can reduce nasal resonance and improve speech intelligibility.[2-4]

In maxillofacial prosthetic treatment, it is important to evaluate patients' speech function. One approach to evaluating hypernasality in quantitative measurement is using a nasometer. This is a computer-based instrument that can detect nasality by measuring acoustic energy captured by two microphones for the nose and mouth attached to the upper and lower sides of a metal plate that is horizontally positioned at the philtrum.[3] The nasometer is used in maxillofacial prosthetic rehabilitation because it is objective, simple, and less invasive.[4]

Dalston et al. found nasalance valuable for assessing the speech of patients with velopharyngeal impairment, comparing the results of the test with the results of clinical evaluation.[1] Reliability and the validity of the method has been confirmed by other researchers.[5,6] Eckardt et al. used nasalance measurements to compare speech outcomes after reconstruction surgery and prosthetic rehabilitation of maxillectomy patients.[4] Prunkngarmpun et al. measured the nasalance of maxillectomy patients using monosyllabic test words.[7]

These examples indicate a research focus on hypernasality, which is a common phenomenon in maxillofacial defect patients. However, there is another speech impairment called hyponasality, which is low nasality especially in nasal sounds. Hyponasality is defined as a condition in which the nasal consonants "m," "n," and "ng" and adjacent vowels are produced with less than the normal amount of nasal resonance.[8] Hyponasality is typically

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caused by a reduction in nasal cavity resonance, usually due to anatomical obstruction of the nasal cavity such as choanal atresia, nasal polyps, and septal deviation.[9]

In our maxillofacial prosthetics clinic, patients sometimes show hyponasality that appears to be related to the prosthesis. This case report provides an example of speech aid adjustments that account for not only hypernasality but hyponasality according to results of a nasalance examination.

CASE REPORT

The patient was a 70-year-old man who presented to our clinic with a chief complaint of a broken speech aid that had been made 15 years earlier. The clasps on the left and right first molars were broken. He was born with an abnormal oral condition and had plastic surgery in his youth, but details were unknown. His history was otherwise unremarkable except for having tuberculosis 30 years earlier. He had no known food or medication allergies. There was a perforation in his soft palate connecting the nasal and oral cavities. The soft palate was sutured to the lateral wall of the pharynx allowing no other airway. Teeth #7, #8, #9, and #10 were missing (Fig. 1).

Fig 1. Intraoral view of the patient.

Fabrication of a new speech aid was planned. An impression was made using an individual tray and polyvinylsiloxane impression material (Examix fine, GC, Tokyo, Japan). The occlusal relationship was recorded using an occlusal base. The speech aid was designed using wire clasps, cast clasps, and artificial teeth. After the wax try-in, the speech aid was processed with heat polymerizing acrylic resin (Acron GC dark pink, GC), polished, and then inserted into the patient's mouth (Fig. 2). Although he felt no pain using the speech aid and had no issue with retention or occlusion, he complained about the quality of his speech. High nasality and poor sealing of the bulb was observed and so the bulb was relined with acrylic resin (Rebase II, Tokuyama Dental Corporation, Tokyo, Japan). After this, his speech sounded better but he had difficulty breathing. The bulb was readjusted with a carbide bur to cut the rear part of the bulb until no pressure was observed, as determined using pressure indicating paste, and a gap of about 1 mm was achieved between bulb and the lateral wall. Nasalance was measured before and after this adjustment. Finally, the bulb was polished with a polishing bur.

Fig 2. Fabricated speech aid and intraoral view of it in position.

Nasalance was measured using a nasometer (Nasometer Model 6400 KayPENTAX, Lincoln Park, NJ, USA) (Fig. 3). After calibrating the nasometer, the headset was banded to the patient's head and the metal separation adjusted under patient's nose parallel to the occlusal plane. The patient was asked to utter monosyllables and sentences consisting of non-nasal sounds representing different intraoral pressures[10] as well as monosyllables and sentences including nasal sounds,[11] as shown in Table 1. All recordings were repeated three times. Software automatically calculated nasalance as a percentage of acoustic energy: nasal/total (nasal + oral). The highest nasalance and mean nasalance scores were recorded for each test word and sentence, and the average value of three repeated measurements was calculated.

The patient was satisfied with the adjusted speech aid as he could breathe well and speak easily. Although his speech sounded more nasal with the adjusted speech aid than with the unadjusted

speech aid, both were intelligible. Figure 4 shows mean nasalance before and after adjustment of the bulb. Mean nasalance was low in both non-nasal and nasal words and sentences before adjustment and was increased in both after adjustment. Figure 5 shows the highest nasalance before and after adjustment of the bulb. Some syllables showed lower nasalance before adjustment and higher nasalance after adjustment.

All procedures were performed in accordance with the Declaration of Helsinki. This study was approved by the Ethics Committee of the Faculty of Dentistry Tokyo Medical and Dental University (Approval no. D2017-080-01).

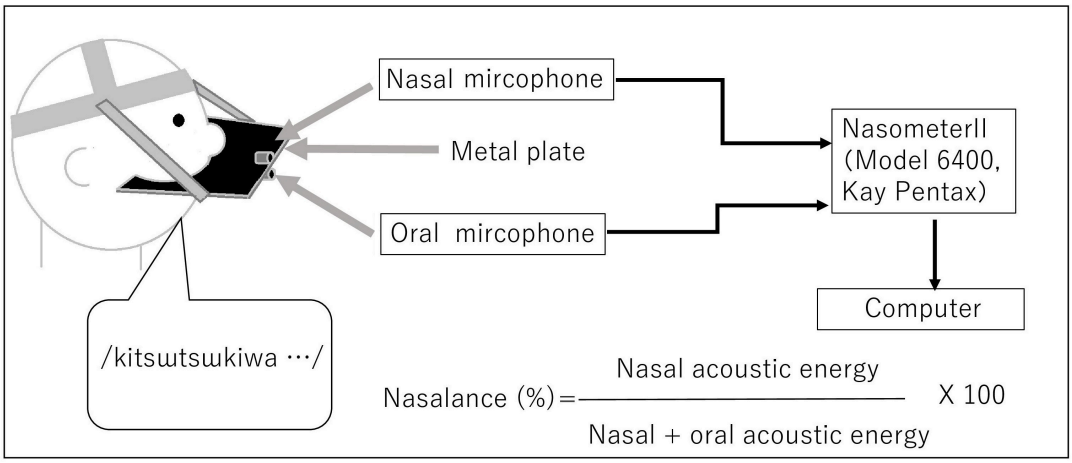

Fig 3. Nasalance measurement.

DISCUSSION

In this case, a nasalance test was used to confirm the voice coming through the patient's nose. Another option for evaluating nasalance in order to adjust a speech aid is simply listening to the patient speaking some words. Although this method does not require any special devices, the evaluation is subjective and it can be difficult to compare subtle differences and objectively apply the results. A mirror fogging test is another option to see the nasal leakage. If the mirror has a scale, it is also possible to quantify the air flow from the nose. In the present case, the speech aid was adjusted appropriately through a detailed phonetic examination using multiple test words and sentences consisting of syllables representing different intraoral pressure and manner of articulation. According to Daltson et. al. the threshold for the hypernasality was 32% nasalance,[1] and Sweeney et.al. reported 51% nasalance in the nasal sentences in Irish boys.[12]

Table 1. Test syllables and words used for nasalance analysis.

			monosyllables/sentences
non-nasal sounds	monosyllables	low pressure	/i/
		high pressure	/tsɯ/
	sentences	low pressure	/yoiɯaoi/
		high pressure	/kitsɯtsɯkiɯa kiotsɯtsɯkɯ/
		mixed	/dobɯtsɯtatʃiɯa sorote ɯtao ɯtata/
nasal sounds	monosyllables		/na/
			/ma/
			/ni/
			/mi/
	sentences		/inɯtonekowa nakagawarɯi/
			/akatʃanni amaimirɯkɯo yarɯ dʒikandes/

In our case before the adjustment, the results indicated comparatively lower nasalance with the production of not only non-nasal sounds but nasal sounds. Therefore, we cut out part of the speech aid to resolve this issue. Although nasalance of some non-nasal sounds increased, the patient was satisfied with the outcome. The nasometer provided objective information that facilitated problem-solving and enabled a detailed assessment of the effect of the adjustments on patient's voice. However, the nasalance test also has some disadvantages. There is only limited time in a clinic to conduct the nasalance test and it can be difficult to detect when some patients are fatigued and show more nasalance when they speak longer. Thus, while adjusting prosthetics in the clinic setting, careful observation is also needed when patients are speaking naturally.

CONCLUSION

A speech aid was successfully adjusted based on results of nasalance testing using nasal and non-nasal test words with consideration of both hyponasal and hypernasal speech.

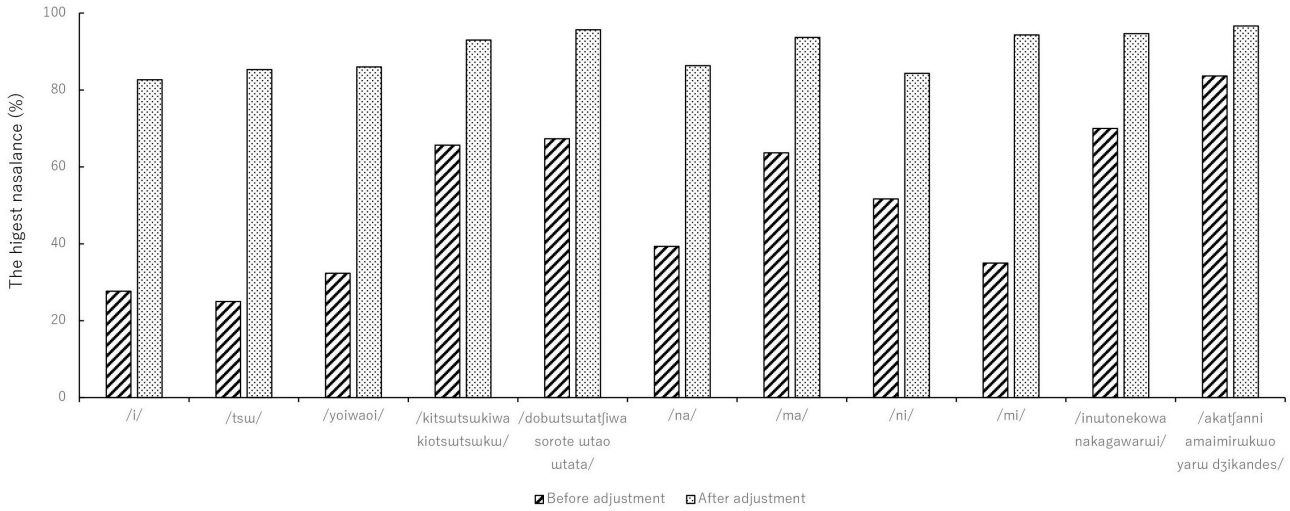

Fig 4. Highest nasalance before and after adjustment.

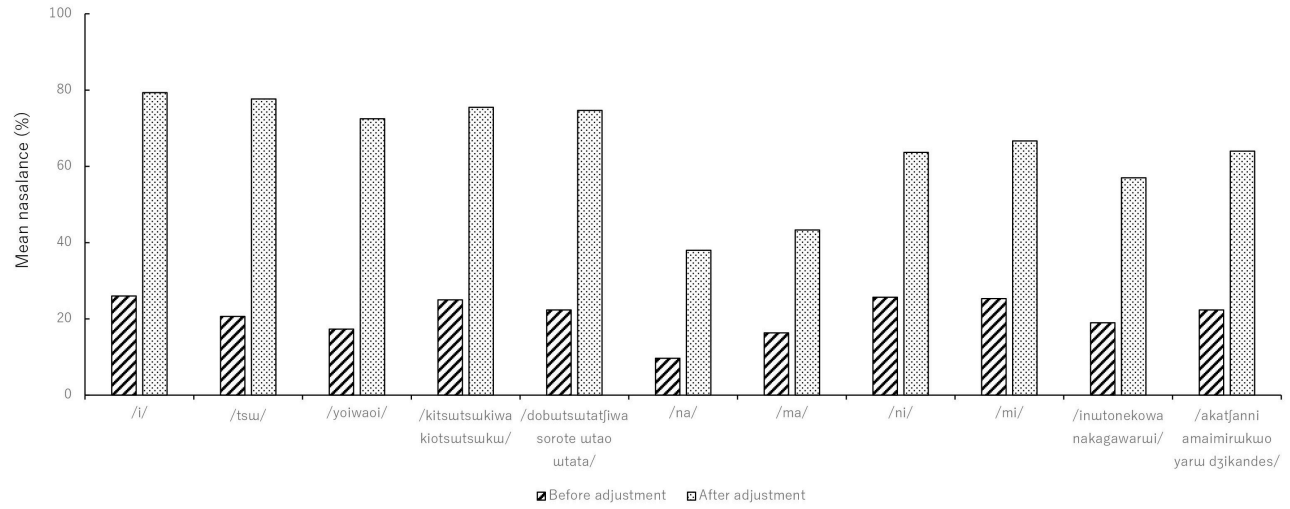

Fig 5. Mean nasalance before and after adjustment.

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